WE CLAIM:

1. A method of combusting hydrocarbon fuel, comprising:

compressing an air stream in a compressor;

dividing the air stream into at least one air staging valve air stream and at least one secondary air stream;

controllably dividing said air staging valve air stream into at least one bypass flow stream, and at least one main combustion air stream;

introducing said main combustion air stream into a fuel preparation section, wherein main fuel is injected and mixed to form a pre-catalyst mixture;

introducing said pre-catalyst mixture into a catalyst section, wherein a catalyst is introduced and partially oxidizes the fuel by contacting said pre- catalyst mixture with an oxidation catalyst in a catalytic oxidation stage, thereby generating a heat of reaction and a partial oxidation product stream comprising hydrocarbons and carbon monoxide;

combusting said partial oxidation product stream, in a main combustor, at a condition at which appreciable quantities of thermal NO_x are not formed, thereby generating an effluent gas stream;

introducing said effluent gas stream to at least one combustor;

introducing said secondary air stream to at least one combustor;

introducing said bypass flow stream to at least one combustor; and

wherein the temperature and composition of said partial oxidation product stream are selected to control simultaneously the amounts of NOx formed in said main combustor and the stability of the flame in said main combustor, thereby controlling the total amount of NO_x in said exit effluent gas stream.

2. A method as in claim 1, further comprising the steps of:

combining said bypass flow stream and said secondary air stream to form an exit profile control air stream; and

introducing said exit profile control air stream to at least one combustor.

3. A method as in claim 2, further comprising the steps of

combining said effluent gas stream with said exit profile control air stream to form an exit effluent gas stream; and

introducing said exit effluent gas stream to at least one combustor.

4. A method as in claim 1, further comprising the step of introducing said secondary air stream to said main combustor.

5. A method as in claim 1, further comprising the step of introducing said bypass flow stream to said main combustor.

6. A method as in claim 1, further comprising a valve for controllably dividing said air staging valve air stream.

7. A method as in claim 1, wherein the temperature and composition of the partial oxidation product stream are selected to control simultaneously the amount of thermal NO_x and prompt NO_x formed in the main combustor.

8. A method as in claim 1, wherein said catalyst is selected from the group consisting of platinum, rhodium, iridium, ruthenium, palladium, chromium oxides, cobalt oxides, alumina and mixtures thereof.

9. A method as in claim 1, wherein said fuel is in liquid form.

10. A method as in claim 1, wherein said fuel is in gaseous form.

11. A method as in claim 3, further comprising the step of delivering said exit effluent gas stream to a turbine.

12. A method of combusting hydrocarbon fuel, comprising:

compressing an air stream in a compressor;

dividing the air stream into at least one air staging valve air stream and at least one secondary air stream;

controllably dividing said air staging valve air stream into at least one bypass flow stream, and at least one preheater air stream;

allowing a portion of said preheater air stream to be divided to form a main combustion air stream;

mixing preheater fuel with said preheater air stream to form a fuel/air mixture;

combusting said fuel/air mixture in a preheater combustor and creating a fuel/air product stream;

mixing said fuel/air product stream with said main combustor air stream and introducing the resultant mixture into a fuel preparation section, wherein main fuel is injected and mixed to form a pre-catalyst mixture;

introducing said pre-catalyst mixture into a catalyst section, wherein a catalyst is located and partially oxidizes the fuel by contacting said pre-catalyst mixture with an oxidation catalyst in a catalytic oxidation stage, thereby generating a heat of reaction and a partial oxidation product stream comprising hydrocarbons and carbon monoxide;

combusting said partial oxidation product stream, in said main combustor, at a condition at which appreciable quantities of thermal NO_x are not formed, thereby generating an effluent gas stream; and

wherein the temperature and composition of said partial oxidation product stream are selected to control simultaneously the amounts of NOx

formed in said main combustor and the stability of the flame in said main combustor, thereby controlling the total amount of NOx emissions.

13. A method as in claim 12, further comprising the steps of:

combining said bypass flow stream and said secondary air stream to form an exit profile control air stream; and

introducing said exit profile control air stream to at least one combustor.

14. A method as in claim 13, further comprising the steps of:

combining said effluent gas stream with said exit profile control air stream to form an exit effluent gas stream; and

introducing said exit effluent gas stream to at least one combustor.

15. A method as in claim 12, further comprising the step of introducing said secondary air stream to said main combustor.

16. A method as in claim 12, further comprising the step of introducing said bypass flow stream to said main combustor.

17. A method as in claim 12, further comprising a valve for controllably dividing said air staging valve air stream.

18. A method as in claim 12, wherein the temperature and composition of said partial oxidation product stream are selected to control simultaneously the amount of thermal NO_x and prompt NO_x formed in said main combustor.

19. A method as in claim 12, wherein said catalyst is selected from the group consisting of platinum, rhodium, iridium, ruthenium, palladium, chromium oxides, cobalt oxides, alumina and mixtures thereof.

20. A method as in claim 12, wherein said fuel is in liquid form.

21. A method as in claim 12, wherein said fuel is in gaseous form.

22. A method as in claim 12, further comprising the step of vaporizing a liquid fuel within said preheater.

23. A method as in claim 12, further comprising the step of delivering said exit effluent gas stream to a turbine.

24. A method of combusting hydrocarbon fuel, comprising:

compressing an air stream in a compressor;

dividing the air stream into a first air staging valve air stream, a second air staging valve air stream and one secondary air stream;

utilizing an air staging valve to controllably divide said first air staging valve air stream into a first bypass flow stream and a first preheater air stream;

utilizing an air staging valve to controllably divide said second air staging valve air stream into a second bypass flow stream and a second preheater air stream;

allowing a portion of said first preheater air stream to be divided to form a first main combustion air stream;

allowing a portion of said second preheater air stream to be divided to form a second main combustion air stream;

mixing preheater fuel with said first preheater air stream to form a first fuel/air mixture;

mixing preheater fuel with said second preheater air stream to form a second fuel/air mixture;

combusting said first fuel/air mixture in a first preheater combustor and creating a first fuel/air product stream;

combusting said second fuel/air mixture in a second preheater combustor and creating a second fuel/air product stream;

mixing said first fuel/air product stream with said first main combustor air stream and introducing the resultant mixture into a first fuel preparation section, wherein main fuel is injected and mixed to form a first pre-catalyst mixture;

mixing said second fuel/air product stream with said second main combustor air stream and introducing the resultant mixture into a second fuel preparation section, wherein main fuel is injected and mixed to form a second pre-catalyst mixture;

introducing said first pre-catalyst mixture into a first catalyst section, wherein a catalyst is introduced and partially oxidizes the fuel by contacting said first pre-catalyst mixture with an oxidation catalyst in a catalytic oxidation stage, thereby generating a heat of reaction and a first partial oxidation product stream comprising hydrocarbons and carbon monoxide;

introducing said second pre-catalyst mixture into a second catalyst section, wherein a catalyst is introduced and partially oxidizes the fuel by contacting said second pre-catalyst mixture with an oxidation catalyst in a catalytic oxidation stage, thereby generating a heat of reaction and a second partial oxidation product stream comprising hydrocarbons and carbon monoxide;

combusting said first partial oxidation product stream, in a first main combustor, at a condition at which appreciable quantities of thermal NO_x are not formed, thereby generating a first effluent gas stream;

combusting said second partial oxidation product stream, in a second main combustor, at a condition at which appreciable quantities of thermal NO_x are not formed, thereby generating a second effluent gas stream;

combining said first effluent gas stream, said second effluent gas stream, said first exit profile control air stream, and said second exit profile control air stream to form an exit effluent gas stream,

wherein the temperature and composition of said first partial oxidation product stream and said second partial oxidation stream are selected to control simultaneously the amounts of NO_x formed in the main combustor and the stability of the flame in said first main combustor and said second combustor, thereby controlling the total amount of NO_x in the exit effluent gas stream.

25. A method as in claim 24, wherein the temperature and composition of the partial oxidation product stream are selected to control simultaneously the amount of thermal NO_x and prompt NO_x formed in said main combustor

26. A method as in claim 24, wherein said catalyst is selected from the group consisting of platinum, rhodium, iridium, ruthenium, palladium, chromium oxides, cobalt oxides, alumina and mixtures thereof.

27. A method as in claim 24, wherein said fuel is in liquid form.

28. A method as in claim 24, wherein said fuel is in gaseous form.

29. A method as in claim 24, further comprising the step of vaporizing a liquid fuel within the fuel preparation section.

30. A method as in claim 24, further comprising the step of delivering said exit effluent gas stream to a turbine.

31. A system for combusting hydrocarbon fuel, comprising:

an air supply for supplying air from a compressor to the air inlet;

an air inlet for entrance of said air mixture from said compressor;

at least one air staging valve, wherein said air staging valve directs air to a catalyst module and a bypass manifold;

at least one a bypass manifold for receiving said air directed from said air staging valve;

at least one catalyst module for receiving said fuel and air directed from said air staging valve;

at least one catalyst exit duct for delivering said fuel and air from said catalyst module to a main combustor; and

an exit for delivering the effluent gas stream generated by the main combustor to a turbine.

32. The system as in claim 31, further comprising:

at least one preheater combustor, said preheater combustor receiving air directed from said air staging valve and being connectedly situated upstream from said catalyst module.

33. A system as in claim 31, further comprising a cooling and dilution flow port for the transport of compressed air.

34. A system as in claim 31, further comprising a turbine for the receipt of said effluent gas stream.

35. A system as in claim 31, wherein said system is enclosed in a pressure casing.